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moval of bacteria rests on the town drawing water from streams rather than on the community which discharges a reasonable purified sewage into them. In chapter five he points out the difficulty of securing good ground water supplies in America and contrasts this condition with that which obtains in northern Europe, particularly in Germany. It is evident that the water supplies of the United States must be drawn mainly from rivers and in this connection the author might well have emphasized somewhat more distinctly than he has done the modern dictum of sanitary science that no surface supply can be considered entirely safe for drinking without preliminary treatment. Filtered river and lake supplies must in the end offer the well-nigh universal solution of the water problem.

The question of tastes and odors in water is particularly well treated. Their origin is discussed in chapter one, a clear distinction being made between the odors of putrefaction produced at the bottom of reservoirs and the odors caused by the growths of organisms at their surface. The merits of stripping and of the copper sulphate treatment are conservatively handled and in chapter nine the removal of tastes and odors by filtration and aeration is discussed.

The subject of water filtration in general suffers a little, as pointed out above, by the lack of preliminary general statements, but the account of recent progress is excellent and the discussion of the possibility of securing a higher percentage purification than is obtained by sand filters to-day is eminently suggestive. Here, as elsewhere, the engineer can furnish any results for which it is worth while to pay.

The last six chapters of the book must be particularly commended; here, Mr. Hazen succeeds admirably in making complicated problems stand out clearly in their main outlines. In chapter eleven the fundamental engineering principles underlying construction, with its necessary allowance for excessive demands, and in chapter twelve the problem of securing adequate pressure, are excellently treated.

Chapter thirteen contains a good statement of the importance of metering water with a

table which shows in a striking way the excessive consumption, in the neighborhood of 200 gallons per capita per day, in the large cities which have no meters, a wanton waste of water which is cut down more than three quarters by the installation of a considerable proportion of metered services.

Chapters fourteen and fifteen deal with the financial aspects of the water-works problem. Mr. Hazen estimates that the amount of money spent on construction and maintenance of water-works is no less than thirty millions per year and that, of this, something like one quarter is wasted by careless and inexperienced methods. The problem of securing pure and wholesome water supply is a difficult one and requires technical expert service of a high grade.

It might be shown how in some lines of work the development is so rapid that even the most recent text-books are hopelessly out of date; how the subjects are becoming so complex that only the principles and not the important details can be treated in them; how the most efficient works are designed by groups of men, each attending to the parts which he best understands, and all under the general direction of a chief who has a clear idea of the end to be reached and the way of reaching it, though he may know less of many of the details than his subordinates; how the only way to learn a business is to be brought up in it; and how it can not be learned by a casual inspection from the outside.

Mr. Hazen rightly pays a tribute to the faithful, devoted and inadequately remunerated work of water boards and water superintendents at the present day, but his presentation makes it increasingly clear that the water supply problem is one of the many municipal questions which must be treated as technical engineering problems demanding expert service, properly rewarded, and unfettered by any demands other than those of economy and efficiency. The attainment of these ends will be furthered appreciably by a book so excellent, in the main, as Mr. Hazen's.

C.-E. A. WINSLOW

Die Ausgleichungsrechnung nach der Methode der Kleinsten Quadrate. By F. R. HELMERT, Director of the Royal Prussian Geo-

detic Institute. Leipzig and Berlin, B. G. Teubner. 1907. Second edition. Pp. xviii + 578.

In preparing the well-known first edition of this work Professor Helmer had in view the needs of the physicist, the astronomer and the geodesist rather than those of the mathematician; and, though the treatment of the subject was of necessity mathematical, the emphasis was not placed upon the more intricate parts of the mathematical theory. As a result the book gave a clear presentation of the *method* of least squares and supplemented it by a mathematical discussion which was ample for all ordinary purposes and which in some particulars went beyond the range of the ordinary texts on the subject. Numerous well-chosen problems furnished illustrations of the details of the use of the method in the chief cases.

The plan of the earlier part of the new edition is substantially that of the former one, though minor changes have been made. Nor does this adherence to the plan of a book thirty-five years old necessarily imply a defect in the new work. For the method of least squares is one of the few advanced branches of mathematical science in which such a proceeding is not inappropriate.

Certain features common to both editions deserve notice, and of these one is the treatment of the law of error. No conclusive argument in favor of this law has been given and the author has chosen to base it upon its accord with the results of observation. This is commendable, for it tends to clear a state of affairs which some one has characterized by saying of the law of error that both mathematicians and physicists accept it, the former because they believe the latter have obtained sufficient experimental evidence and the latter because they believe that it has been mathematically demonstrated. It is true that in the second edition one of the numerous mathematical arguments in favor of the law is included, but it is given a secondary place. Moreover, the author expressly considers several possible laws of error.

Clear explanations of the most important ideas of the subject are given early in the

work and accompanying them are illustrations of their practical use. Then follows the development of the subject along standard lines from the discussion of direct observations of equal weight to that of indirect determinations of the values of quantities which are not independent.

Of the improvements made in preparing the new edition, one notes an increase in the amount of space devoted to pure theory, particularly in regard to the relations to each other of various kinds of errors of observation and in regard to the application of the method to interpolation. The size of the volume has been increased from 348 to 578 pages, and a large part of this increase is made up of the last three chapters, which deal with technical problems of physical, astronomical and geodetic work.

Pleasing are the frequent references to original sources and the excellence of the examples by means of which the theory is illustrated. A detailed table of contents and an index make all of the matter in the book accessible to the reader, and the publishers have made the book attractive in appearance. An occasional sacrifice of mathematical rigor for the sake of brevity will not prevent even an exacting reader from regarding the text as an excellent treatise on the subject.

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SCIENTIFIC JOURNALS AND ARTICLES

THE opening (October) number of volume 14 of the *Bulletin of the American Mathematical Society* contains the following articles: "Application of a Definite Integral involving Bessel's Functions to the Self-Inductance of Solenoids," by A. G. Webster; "On the Apsidal Angle in Central Orbits," by F. L. Griffin; "The Maximum Value of a Determinant," by E. W. Davis; "The Invariant Substitutions under a Substitution Group," by G. A. Miller; Shorter Notices (Tannery's *Leçons d'Algèbre et d'Analyse à l'Usage des Elèves des Classes de Mathématiques spéciales*, Tome Premier, by F. Cajori; Tannery's *Leçons d'Algèbre et d'Analyse*, Tome Second, by G. W. Myers; Pionchon's *Mathématiques*.